

# ASSESSMENT OF FARMERS' PRONE STATE TO NATURAL DISASTERS: A CASE OF MAINSTREAM HYDROPOWER DEVELOPMENT IN THE LOWER MEKONG DELTA, VIETNAM

**Hoang Ha Anh<sup>1,2,\*</sup>, Hoang Anh Trung<sup>3</sup>, Nguyen Ngoc Thuy<sup>4</sup>**

<sup>1</sup>*College of Economics and Management, Northwest A&F University,  
3 Taicheng Road, Xianyang, Shaanxi, China*

<sup>2</sup>*Faculty of Economics, Nong Lam University, Linh Trung Ward, Thu Duc District,  
Ho Chi Minh City, Vietnam*

<sup>3</sup>*Faculty of Environment and Natural Resources, Ho Chi Minh University of Technology,  
12 Nguyen Van Bao Street, Go Vap District, Ho Chi Minh City, Vietnam*

<sup>4</sup>*Office of International Relationship, Nong Lam University Ho Chi Minh city,  
Linh Trung Ward, Thu Duc District, Ho Chi Minh City, Vietnam*

\*Email: [hoanghaanh@hcmuaf.edu.vn](mailto:hoanghaanh@hcmuaf.edu.vn)

Received: 5 May 2016; Accepted for publication: 26 June 2016

## ABSTRACT

The study provides a comprehensive view at the prone state of the Mekong Delta under baseline conditions of hydropower development. Communities in Vietnam Mekong Delta have main income sources from rice farming, fishing and aquaculture, so changes in floods pattern or salinity can directly affect people's livelihoods. Among 13 provinces in Mekong River Delta, there are 9 provinces that have moderate Potential Impact Sub-Index (PII). Tra Vinh has the PII since its population is affected by both floods and salinity more heavily than other provinces. The provinces that have higher PII also have higher Social Vulnerability Index (SVI) to impacts. All provinces except Long An have moderate vulnerability to impacts because Long An not only has low PII but also high Adaptive Capacity Sub-Index (ACI) which makes it less vulnerable. Tra Vinh has highest SVI because of its exposed state to floods and salinity and high poverty rate. The results show that majority of Mekong River Delta are vulnerable to floods and salinity.

**Keywords:** floods, social vulnerability index, Mekong River Delta, hydropower.

## 1. INTRODUCTION

The Mekong River is one of the longest rivers in the world with almost 4800 km length. The total area of Mekong Basin is about 795,000 km<sup>2</sup> and divided into Upper Mekong Basin (UMB) and Lower Mekong Basin (LMB). The LMB is a vast area which contains Lao PDR, Thailand, Cambodia, and Vietnam. There are 60 million people in the LMB of which 50 % living within 15 km of the river banks [1]. People living in the LMB rely on Mekong River to

provide them resources that necessary for their livelihood. Agriculture, aquaculture and fishing are dominant economic activities in Thailand, Cambodia and Vietnam.

Due to many natural resources advantages, the LMB is currently undergoing rapid development. Twenty six hydropower projects are under construction on various tributaries. The full hydropower potential of the LMB is estimated at 30,000 megawatt, but only about 10 % were developed to date [1]. Eleven hydropower projects have been proposed for the Mekong River mainstream in Lao PDR and Cambodia to extract the available hydropower capacity. Construction and operation of any or all of these projects could potentially have substantial and wide ranging environmental and socio-economic effects in all 4 LMB countries. The downstream floodplains of Cambodia and Viet Nam, which make up the Mekong River Delta, in particular could experience the greatest impacts.

The Vietnam Mekong Delta is also known its prone state to floods and salinity because the elevation of the delta is very low [2]. Usually, drought and salinity occur at the first half of the year and floods come at the second half. However, in the future both flood regime and salinity intrusion might be changed and become unpredictable when 11 proposed dams in Cambodia and Lao PDR are constructed. The operating of these dams will not only affect the ecosystems and environment but also place negative impacts on the livelihoods of people living in the Mekong Delta in Vietnam. Therefore, this study is conducted to assess the current prone state of people in the Vietnam Mekong Delta. The specified objectives of this study are: (a) to describe the livelihood in current conditions of hydropower development and (b) to evaluate the social vulnerability index of communes to flood and salinity intrusion. The results of the research can be used as indicators to predict possible outcomes may happen on social aspect in the region when proposed hydropower plants are constructed.

## **2. MATERIALS AND METHODS**

### **2.1. Methodology**

#### *2.1.1 Study area*

The study area includes 13 provinces in the Mekong Delta in Vietnam which are located at the southern.

#### *2.1.2. Livelihood impact assessment methods*

The methodology proposed for this study incorporates lessons learned from previous frameworks used to assess livelihoods in the LMB which are : Sustainable Livelihoods Framework (SLF) [3]; Strategic Environmental Impact (SEA)/Social Systems Assessment (SSA) [4]; and Social Impact Monitoring and Vulnerability Assessment (SIMVA) [5]. Potential impacts from hydropower on social system of Mekong Delta floodplains will be determined by quantitative assessment. The concept of livelihood in the study means a set of activities includes abilities, assets, income and activities that local people have to acquire in order to secure the necessities of life. The assessment in the study will focus on vulnerable groups within affected area such as farmers, fishers and people who are depended on water resources.

The assessment is conducted based on the concept of Social Vulnerability Index (SVI). SVI refers to people, organizations and society that no longer have capability to sustain negative impacts from different stresses. A SVI will be determined by combining two separated sub-

indices that represent potential impacts and adaptive capacity. The potential impacts sub-index (PII) combines effects related to exposure, dependence and sensitivity. The adaptive capacity sub-index (ACI) is a measure of the exposed populations resilience and adaptive capacity.

Table 1. Indicators of Social Vulnerable Index.

Sub – Index	Indicators	Sub-indicators/Variables	Unit	Correlation to SVI
Potential impacts sub-index (PII)	Exposure	(X1) People affected by flooding	People	+
		(X2) People affected changes in area affected by salinity changes	People	+
		(X3) People affected by changes in livelihood related to agricultural activity	People	+
		(X4) People affected due by changes in fishery activity	People	+
	Sensitivity	(X5) People engaged in farming	People	+
		(X6) People engaged in fishing.	People	+
		(X7) People engaged in aquaculture	People	+
		(X8) Households that have main income sources from agriculture, aquaculture and forestry	Households	+
		(X9) Average Net income/household (hh) from rice production	VND	-
		(X10) Average Net income/hh from fishery	VND	-
		(X11) Average Net income/hh from aquaculture	VND	-
		(X12) Households have alternative livelihood options besides agriculture, aquaculture and fishery	%	+
	Adaptive capacity	(X13) Households below poverty rate	%	+
		(X14) Dependency rate. Number of people below and over working age.	People	+
		(X15) Unemployment rate	%	+
		(X16) Households are association members or in farmers associations, women association, extended clubs, cooperation clubs.	%	-
		(X17) Households that attended training courses, technical courses, management skill courses	%	-
		(X18) Households can identity flood coming	%	-
		(X19) Households can store drinking water/food	%	-

Each of the sub-indexes contains many indicators which are presented in Table 1. SVI firstly will be calculated at communal level through household survey in the study area. Then results from communes will be up-scaled to district and province level to characterize the baseline conditions and vulnerable indexes for each area. The upscale process is assumed that surveyed households and communes are representative for conditions within impact assessment area. The primary impacts from proposed hydropower dams that can affect communities' livelihood are changes in flood and salinity intrusion regimes. SVI are determined firstly on commune level based on survey data then scaling up for district level. Due to limited in time and resources, in this study the weights of indicators are assumed to be balanced.

## 2.2. Data collecting

Data for livelihood assessment was collected mainly from official sources of Vietnam government. Communal data from 2011 to 2012 was collected from the General Statistical Office through Agriculture, Forestry and Aquaculture survey in 2011. Data from the survey includes 1575 communes in 13 provinces of Mekong Delta. The information contains demographic of households; agricultural production, aquaculture and fishing; and labor force. Besides, related data was also gained from SIMVA study of MRC which was conducted in 2008 and 2009 [5]. Supplement data was collected from FAO, individual studies, field survey and reports conducted by MRC (2011).

To supplement remained data regarding livelihood options and suffered conditions by floods and salinity intrusion, the study surveyed 1260 households in the Mekong Delta. Key Informant Panel (KIP) and Participatory Rural Appraisal (PRA) surveys were also conducted to make a qualitative report to complement with quantitative estimations.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

Most of the communes in Vietnam Mekong Delta are located in floodplain areas. Due to its mostly flat terrain, majority of the region's land can be used for agricultural production and most of the agricultural land is used for rice cultivation. Kien Giang province, An Giang province and Dong Thap province are the best three producers within the region. According to the result of the PRA, floods occur from the end of June until October. Recent big floods occurred in 1996, 2000 and 2011 had caused great losses on rice production, aquaculture, infrastructure and livelihood of the communities.

Table 2. Schedule of disaster in Mekong River Delta. (Source: PRA survey)

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Extreme events	Salinity					Drought			Floods			

Among surveyed communes, Ham Tan commune (Tra Vinh) has 100 % of HH that experienced floods in the last 3 years. In general, 48 % of households in 13 provinces were affected by floods which indicated that a large portion of Vietnam Mekong delta would be vulnerable when flood pattern changes due to the operation of upstream hydropower plants. Regarding to salinity, the most exposed communes are located at coastal area while below 20 % of inland households responded to have experienced salinity in the last 3 years. Salinity usually occurs from January to May; in 2011, coastal provinces were affected by salinity incursion combining with high tides which heavily damaged paddy yield. However, although increases in salinity may damage rice production, it can create favorite environment for shrimp farming which needs brackish water.

In Mekong River Delta of Vietnam, agriculture and aquaculture are main income sources which are presented through the distribution of households that have main income from these sectors. Rice production schedules in Mekong River Delta are different among provinces depend on hydrological regimes and irrigation systems. In places that have completed dike systems, farmers can plant 3 seasons per year even in flood prone or coastal area. In opposite, there are usually only 2 rice seasons per year in places that do not have completed dike systems. Aquaculture in Mekong River Delta is also diverse. Catfish, snakehead, prawn and shrimp are popular production.

### 3.1.1. Social Vulnerability Index (SVI)

Firstly, PII includes exposure and sensitivity of the communities. Among 13 provinces in Mekong River Delta, there are 9 provinces that have moderate PII. Tra Vinh has the highest PII since its population is affected by both floods and salinity more heavily than other provinces. Inland provinces tend to have lower PII because they are not affected by salinity as much as coastal provinces. The potential impacts from floods and salinity on provinces might have mitigated by dike systems. After the big floods in 1996, 2000, 2011 and the salt incursion in 2011, many irrigation constructions were invested to prevent floods from upstream and salinity from coastal zones.

In term of ACI, most of provinces in Mekong River Delta have high ACI which represent their high capabilities to resist and adapt to impacts. Provinces that have more households under poverty rate tend to have lower ACI. High value of ACI makes communities in Mekong River Delta have more capabilities to respond to impacts. Tra Vinh, Hau Giang and Soc Trang are provinces that have highest percentage of households under poverty standard in the Mekong River Delta, which indicates that they have low resilience and adaptive capacity to floods and salinity.

Finally, the result of SVI is shown in Figure 1. The provinces that have higher PII also have higher SVI to impacts. All provinces except Long An has moderate vulnerability to impacts since Long An not only have low PII but also high ACI which makes it less vulnerable. Tra Vinh has highest SVI because of its exposed state to floods and salinity and high poverty rate. The results show that majority of Mekong River Delta are vulnerable to floods and salinity.

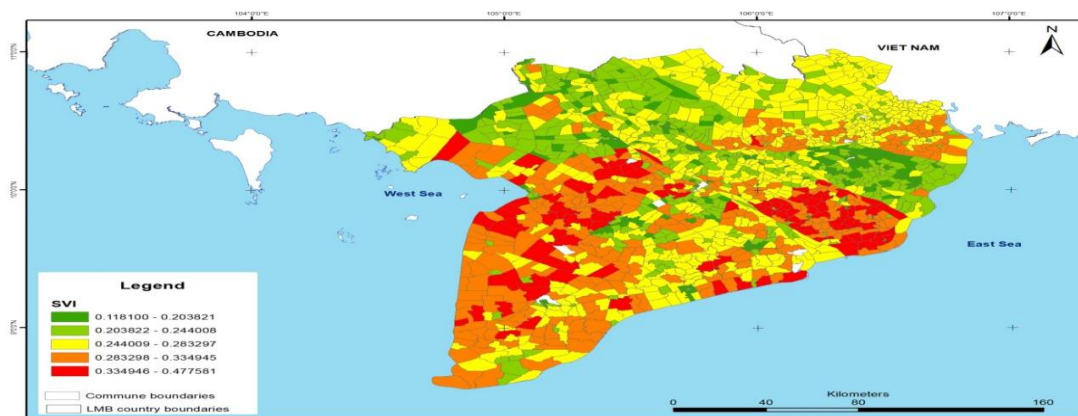


Figure 1. SVI of Mekong River Delta province. (Source: calculation and summary)

### **3.2. Discussion**

In the Mekong Delta, rice farming and aquaculture are dominant livelihood activities. Rice season schedules are different among areas and depend on the hydrological regime and irrigation system. If there are completed dikes, even in flood prone or coastal areas, farmers can grow 3 seasons of rice per year; in opposite, places with uncompleted dike are only allowed to grow 2 rice seasons per year. Although there are dike systems, the risks from floods at upstream provinces and from salinity intrusion at coastal provinces are still high. Salinity intrusion makes Summer-Autumn rice season late in coastal zones compared with flood prone areas because of lacked fresh water. In addition, salinity can affect Winter-Spring rice from flowering stage to harvesting. Aquaculture in Vietnam Mekong Delta is very diversity. People can farm cat fish within 11 months (start from January and harvest in December); fingerlings are farmed throughout the year, each season last for 3 months; snakehead fish is also farmed for 2 seasons per year. Moreover, crayfish and brackish water shrimp are also very popular production models in the region.

Since 1995 until now, there are many irrigation constructions invested to prevent floods at upstream and salinity at coastal zone. Therefore, rice farming area increased rapidly as well as yield, production and income of farmers were also improved. However, the communities also realized many disadvantages of rice farming intense and control salt water intrusion such as: reduced soil fertility, decreased marine resources and dike break risks. Recent big floods were recorded in 1996, 2000 and 2011. Although there were dikes but extreme floods broke them and caused impacts on rice, fruits, live-stocks, fish ponds, infrastructure and people housing. In 2011, coastal provinces were affected by salinity intrusion which caused losses in rice yield.

Beside rice farming and aquaculture, there are some alternative livelihoods for population in Mekong River Delta. Cow farming was mentioned by people in the PRA and had chances to develop since this is a species that is easy to farm and beef price does not have much fluctuation. However, it requires high initial investment and external support. Besides, young labors usually do not want to participate in agriculture and migrate into industrial zones to earn income, but their low and limited skills do not generate high income. At coastal zones, if sea water invades and the weather is dry, farmers can switch from rice into shrimp production.

Regarding trends of extreme events, the result in PRA shows that flood regime is becoming hard to predict and its impacts tend to be worse. The results of PRA and KIP showed another assessment regarding the qualitative aspects of floods and salinity. According to the PRA of rice and aquaculture, although the flood extent and max flood level would be possibly unchanged, but their trends are becoming worse and more difficult to predict. Unpredictable floods can lead to heavily damages since the communities cannot adapt to the impacts in time. This result indicates that the role of regulating from hydropower dams is very critical. Good regulating schedule will not only be able to control floods but also salinity because it is a secondary impact from changes in flow pattern.

In the scenario analysis of PRA, the communities showed high concern and awareness about the negative impacts that hydropower development in upstream can create on Mekong River Delta. Hydropower development in mainstream will greatly affect rice production because flow regimes will have to depend on the operation of hydropower dams, so storing water may create shortage of irrigating water and increase salinity inland.

Besides hydropower development, PRA also showed that floods and salinity will cause high negative impacts on rice production. Therefore, the investment of dikes or changing livelihood can be applied as mitigating and adapting strategies for affected population. The flood

affected area spread all over the Mekong Delta while the salinity intrusion is mainly located at coastal provinces.

*Table 3.* Scenarios analysis from 14 PRAs. (Source: PRA survey)

	Negative impact level				
	Very low (%)	Low (%)	Moderate (%)	High (%)	Very high (%)
Hydropower development	7			14	<b>79</b>
Irrigation development	7	7		<b>57</b>	29
Floods	8	8	31	<b>38</b>	15
Drought			8	<b>50</b>	42
Salinity			20	<b>50</b>	30

When compared with other countries within the Lower Mekong Delta, Vietnamese communities are more vulnerable to combined extreme events. Therefore when the 11 proposed dams are constructed, flow changes probably would make flooding events more unpredictable. As a result of an impact chain, people living at the end of the lower basin have to suffer upstream hydropower development; this result is represented through the estimation of moderate and high PII in the region. Similar conclusion is also stated in the study of Pearse-Smith [6].

From the PII estimation, the final SVI of Mekong Delta indicates that provinces in the region are vulnerable to floods and salinity. Most of the provinces have moderate SVI except for coastal zones. The prone state of the Mekong Delta should have been worse if it did not acquire high capability of adapting and resisting.

Most of the households in the region attended training courses about extreme events; they also have long term experienced in dealing with floods and salinity so that each household can develop their strategies to adapt and mitigate the impacts. This explains why the estimated ACI in the region is relative high.

#### 4. CONCLUSION

Result of the study provides a comprehensive view at the prone state of the Mekong Delta under baseline conditions of hydropower development. Communities in Vietnam Mekong Delta have main income sources from rice farming, fishing and aquaculture, so changes in floods pattern or salinity can directly affect people's livelihoods. In Vietnam, most of provinces are affected by both floods and salinity, so majority of Mekong river delta have moderate PII which means that they are potential to be affected when there is changes in floods and salinity pattern. The inland provinces tend to have lower PII and ACI because they are less affected by salinity intrusion. For SVI estimation, all provinces except Long An has moderate vulnerability to impacts since Long An not only have low PII but also high ACI which makes it less vulnerable. Tra Vinh has highest SVI because of its exposed state to floods and salinity and high poverty rate. The results show that majority of Mekong River Delta are vulnerable to floods and salinity.

Based on the calculation of the PII and SVI, the strategy for hydropower development in Mekong River should consider the potential impact that may happen in Tra Vinh, Kien Giang. Since flood is considered the primary affect from hydropower dams operation so dike and irrigation construction should be appropriate plans to mitigate possible impacts. Besides, adaptive capacity has proven that it can lower the vulnerable state of the areas so people in the

region should be trained and educated about adapting and mitigating when extreme events are predicted to occur.

## REFERENCES

1. MRC - Basin development Plan Program, Phase 2, Assessment of Basin-wide Development Scenarios. Mekong River Commission: Vientiane, Lao PDR, 2011.
2. Luu Thi Nguyet Minh, Garniera J., Gilles B., Didier O., Julien N., Le Thi Phuong Quynh, Trang Hong Thai., Le Lan Anh. – Hydrological regime and water budget of the Red River Delta (Northern Vietnam). *Journal of Asian Earth Sciences* **37** (3) (2010) 219-228.
3. Hossain M., Ut T., and Bose M. - Livelihood systems and dynamics of poverty in a coastal province of Vietnam. *Environment and Livelihoods in Tropical Coastal Zones: Managing Agriculture–Fishery–Aquaculture Conflicts*. CAB International, Wallingford, UK, 2006, pp. 30-47.
4. ICEM - MRC SEA of Hydropower on the Mekong Mainstream, Baseline Assessment Report, 2010.
5. MRC - Social Impact Monitoring and Vulnerability Assessment: Regional Report. Mekong River Commission: Vientiane, Lao PDR, 2010
6. Pearse-Smith S. W. D. - The impact of continued Mekong Basin hydropower development on local livelihoods. *Consilience: The Journal of Sustainable Development* **7** (1) (2012) 73-86.